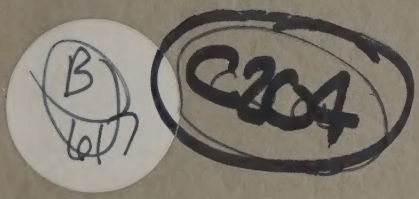
OPERATING INSTRUCTIONS

for

TYPE 1213-A

UNIT CRYSTAL OSCILLATOR

3-B-91



GENERAL RADIO COMPANY

CAMBRIDGE 39 MASSACHUSETTS

NEW YORK CHICAGO LOS ANGELES

U. S. A.

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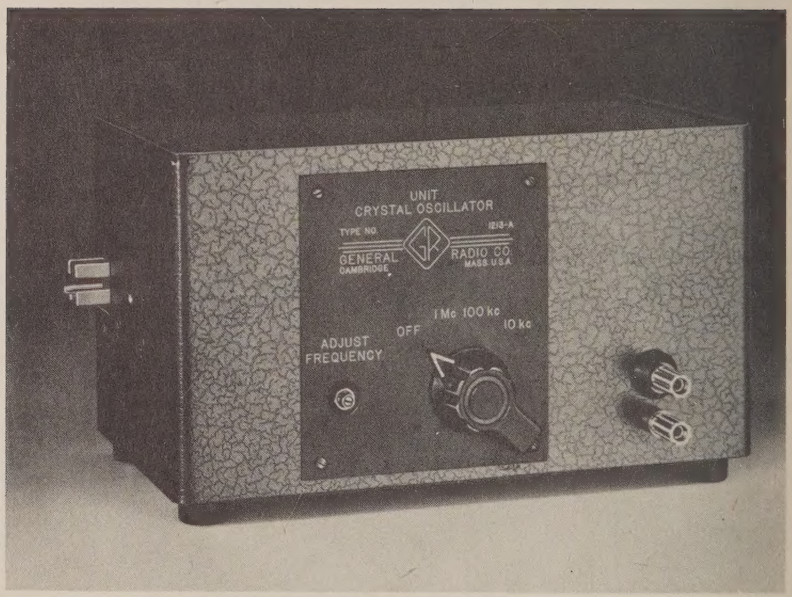


Panel View of Type 1213-A Unit Crystal Oscillator

SPECIFICATIONS

Frequency: 1 Mc, 100 kc, and 10 kc. The crystal has a temperature coefficient of one part per million per degree centigrade. Under normal operating conditions with a constant room temperature, a stability of approximately one part per million can be obtained for a day's operation.

Output: Greater than six volts for all three frequencies.

Harmonics Available: 1000, 250, and 25 Mc, respectively.

Controls: A ceramic wafer switch to select desired output frequencies.

Terminals: Jack-top binding posts provided with standard ¾ inch spacing.

Vacuum Tubes: Three 12AT7-type.

Power Supply: 300 volts dc, 30 ma; 6.3 volts, 1 ampere, ac.

Power Input: With 1203-A or 1204-A Power Supply, 15 to 31 watts, depending upon switch setting.

Accessories Supplied: One mating multipoint connector.

Mounting Black-crackle-finish panel and sides. Aluminum cover finished in clear lacquer.

Dimensions: (Width) 9⅞ x (height) 5¾ x (depth) 6¼ inches.

Net Weight: 3 lbs. 12 oz.

*Licensed under patents of G. W. Pierce and of the Radio Corporation of America.

Operating Instructions
for
Type 1213-A Unit Crystal Oscillator

The Type 1213-A Unit Crystal Oscillator is a simple and inexpensive source of standard frequency harmonics at multiples of 1 Mc, 100 kc, and 10 kc. The short term stability is approximately 1 part per million (0.0001%).

The instrument is useful for receiver testing and calibration, band-edge checking, frequency measurements, and as a source of standard frequencies. With the proper receiving equipment, harmonics of 1 Mc, 100 kc, and 10 kc are available up to 1000 Mc, 250 Mc, and 25 Mc, respectively.

SECTION 1.0 INSTALLATION

1.1 INSPECTION

Before connecting the power supply, remove the dust cover from the oscillator and check to see that the crystal and tubes are securely seated in their sockets. The cover is removed by loosening the two thumb screws located on the right-hand side of the cabinet. After inspecting the crystal and tubes, replace the dust cover and retighten the thumb screws.

1.2 POWER SUPPLY

The instrument, as supplied, requires the addition of a power supply. A recommended supply is the Type 1203-A Unit Power Supply, which plugs directly into the multipoint plug located on the left-hand side of the instrument. The Type 1204-A Unit Variable Power Supply may also be used and is connected in a similar manner. If neither of these supplies is available, any power supply that will provide 300 to 350 volts at 50 milliamperes and 6.3 volts a-c at 1 ampere will be satisfactory. A spare multipoint connector is provided with the oscillator to facilitate connecting a supply other than one of the GR Unit line. When using either of the unit power supplies, the power input is 15 to 30 watts (depending upon switch setting) at 115 volts, 60 cycles. All fuses are located in the power supply.

SECTION 2.0 OPERATION

2.1 CONTROLS

The main operating control is the range selector switch located on the panel. When this switch is in the OFF position, there is no radio-frequency output, but the tube heaters remain energized and ready for use. The heater

power is controlled by the ON-OFF switch on the power supply. When the range selector switch is moved to one of the three output frequencies, the B plus voltage is turned on and the output terminal connected to the proper output network.

2.2 FREQUENCY ADJUSTMENT

The only other control on the panel is a screwdriver adjustment to permit setting the crystal oscillator frequency to zero beat with standard frequency transmissions of the National Bureau of Standards Radio Station WWV. Either the 5-, 10-, or 15-Mc frequency transmissions can be used. See Paragraph 4.1.

2.3 RECEIVER CALIBRATION

In checking the calibration of a receiver, the 1-Mc harmonics should be used as "key points". These points will be relatively far apart on the receiver and are usually easy to locate. The calibration between key points can then be filled in by using the 100-kc or 10-kc harmonics as required. The coupling of the oscillator to the receiver can be varied by moving a length of wire connected to the output terminals, or if the output is too strong without any wire attached to the terminals, the oscillator should be moved several feet away from the receiver.

2.4 FREQUENCY MEASUREMENTS

To measure an unknown frequency, the oscillator is first checked against WWV to make sure that the crystal frequency is exactly 1 Mc. Next, a receiver is tuned to the unknown frequency. Then the nearest 10-kc, 100-kc, or 1-Mc point is located on the receiver by switching the oscillator to the desired output.

When using receivers with a large band-spread dial, interpolation between the nearest 10-kc point and the unknown frequency is easily accomplished, and accuracies in the order of 20 parts per million are easily obtained. The limiting factor is not the accuracy of the crystal, but the ability to read the receiver dial.

The coupling between the oscillator and the receiver should be adjusted so that the signal does not block the receiver. Generally, at frequencies above 15-Mc, there will not be any difficulty due to blocking. However, below this frequency the 1-Mc output may block the receiver and require looser coupling. A lead from the output terminals of the oscillator may be connected directly to the antenna terminals on the receiver. The output impedance of the oscillator is sufficiently high, so that there is no noticeable attenuation of the incoming signal at frequencies below 55-Mc when coaxial antenna feeders are used. However, care must be taken to keep the connecting lead as short as possible, especially at the higher frequencies.

2.5 OTHER USES

For other applications of the crystal oscillator, a little experimenting will usually determine the best method of coupling to the oscillator.

SECTION 3.0 CIRCUIT

3.1 DIAGRAMS

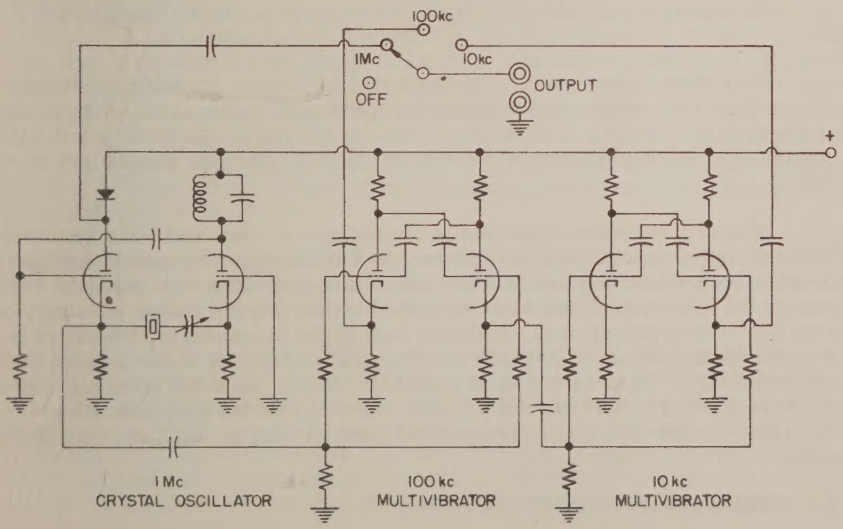
A Schematic Diagram is shown below and a complete wiring diagram is shown on Page 12.

3.2 OSCILLATOR CIRCUIT

A cathode-coupled 1 Mc crystal oscillator is used. The crystal is a plated, mounted, hermetically-sealed, unit with a low temperature coefficient of frequency. The 1-Mc crystal and its series capacitor form a series resonant circuit between the two-low-impedance cathode circuits. Thus, the crystal operates at a low impedance, and any capacitance across it has only a small effect on the frequency. The first half of the twin triode operates as a cathode follower, while the second half is a grounded-grid amplifier. The plate circuit of the amplifier is tuned to 1 Mc, and the voltage appearing across the tuned circuit is fed back to the grid of the cathode follower, thus completing the oscillating circuit. The germanium diode in the plate circuit of the cathode follower is used as a harmonic generator.

3.3 MULTIVIBRATORS

The 100-kc and 10-kc multivibrators are cathode-coupled and are controlled by the 1-Mc oscillator.



Elementary Schematic Diagram for Type 1213-A Unit Crystal Oscillator

3.4 OUTPUT VOLTAGES

The output voltage of all three ranges is in excess of 6 volts. The source impedances are several-hundred ohms for all three ranges.

SECTION 4.0 CALIBRATION AND ALIGNMENT

4.1 CALIBRATION OF CRYSTAL OSCILLATOR FREQUENCY

Calibration of the crystal oscillator frequency against that of a standard frequency or a standard-frequency transmission can be easily accomplished with a communication receiver. The receiver is tuned to 5, 10, or 15-Mc for reception of the standard frequency transmission. If the receiver has an automatic volume control, it should be disabled. Adjust the receiver beat-frequency oscillator to a tone of about 1,000 cycles. Couple the output of the crystal oscillator to the receiver by means of a coupling wire brought near the antenna lead, and set the selector switch (S-1) to 1 Mc. The beat tone in the receiver output will then increase and decrease in intensity at a rate equal to the difference in frequency between the crystal oscillator frequency and the standard frequency. Adjust the panel frequency trimmer to bring this rate to a low value, preferably zero beat. Be sure that you are at zero beat with the standard frequency and not the 1,000-cycle beat frequency. This can be checked by turning off the beating oscillator.

4.2 ADJUSTMENT OF 100-kc MULTIVIBRATOR

The multivibrator should remain locked in for a considerable length of time. However, it may drop out of synchronism due to tube aging, a change in value of the circuit components, tube replacement, or a variation in line voltage. The 100-kc multivibrator adjustment will be found at the back edge of the chassis and to the left. Before altering the adjustment, the position of the shaft should be noted. This is particularly useful should you desire to return to the original position and start over. To reset the multivibrator when only a receiver is available for checking, proceed as follows.

Choose a receiver range where a coverage of 1 Mc is continuous, and check the end points of this range, using the 1 Mc output. Then switch to the 100-kc output and tune in one of the multivibrator harmonics which is not an end point. If the beat note is rough and unsteady, the multivibrator is out of control. If the beat tone is steady, it is in control. Adjust the resistor R-9 (100-kc adj.) to obtain control. Next, starting at one end point and calling it zero, count the number of beats. When the second end point is reached, the count should be 10. If it is less than 10, increase R-9 to obtain control at the correct frequency. If the count is more than 10, decrease R-9 to obtain control at the correct frequency.

4.3 10-kc MULTIVIBRATOR ADJUSTMENT

To check the 10-kc multivibrator, choose a receiver range where a coverage of 100-kc is continuous and check the end points of this range, using the

100-kc output. Then switch to the 10-kc output and tune in one of the harmonics which is not an end point. Proceed as in Paragraph 4.2 to obtain control of the multivibrator and a count of 10. Readjust R-15 (10-kc) if necessary.

4.4. FINAL ADJUSTMENT

When the preliminary multivibrator adjustments have been made, final adjustment is as follows.

With switch S-1 in the 10-kc position, adjust R-15 (10-kc adj.) to the center of the range where the multivibrator locks in.

With S-1 still in the 10-kc position, determine the span of R-19 (100-kc adj.) for a 10-kc output. Note that this span may not coincide exactly with, but does overlap, the span obtained with S-1 in the 100-kc position. Set R-9 to the middle of the overlapping area of the two spans. If necessary, reset R-15 to the center of its lock-in span. Turn S-1 to the 100-kc position and note that the 100-kc output is still locked in. If it's not, repeat Paragraphs 4.2 through 4.4.

4.5 MISCELLANEOUS

Occasionally it will be noticed that the multivibrators are a little sluggish in starting when switching from the 1-Mc output to 100-kc or 10-kc. This is particularly true when the oscillator has been left in the 1-Mc position for several hours and is then switched to 100-kc. The starting time may be as long as a minute or two if the line voltage is low. The delay with higher line voltages is considerably less.

SERVICE AND MAINTENANCE NOTES

This service information, together with the information given in the Operating Instructions, should enable the user to locate and correct ordinary difficulties resulting from normal use.

Major service problems should be referred to our Service Department which will cooperate as far as possible by furnishing information and instructions as well as supplying any replacement parts required.

When contacting our Service Department regarding any difficulties in operation or service of the instrument, the type number of the instrument should always be mentioned. A complete report of the troubles encountered, with specific reference to the numbered paragraphs in the Operating Instructions and the Service Information pertaining to these particular troubles, as well as any further information concerning the use of the instrument and steps taken to eliminate the difficulties, should also be included in any correspondence.

Please write to our Service Department for a Returned Material Tag, which includes shipping instructions, to insure proper handling and identification

before returning any instrument or parts for repair. A purchase order covering material returned for repair should also be forwarded to avoid any unnecessary delay.

1.0 NO OUTPUT ON ALL POSITIONS OF THE SWITCH

1.1 Check that C-3 and C-11 are not shorted. Blow out between the plates with compressed air to remove any dirt or dust that may cause short circuits.

1.2 Check or replace V-1.

1.3 Check that L-1 is not open-circuited.

1.4 If the circuit of V-1 checks according to the tables of resistance and voltage, crystal Q-1 may be defective. This cannot be checked easily except in another Type 1213-A Unit Crystal Oscillator or at the factory.

2.0 LOW OUTPUT ON ALL POSITIONS OF THE SWITCH

2.1 Check that the power supply voltage is 300 to 350 volts d.c. when connected to the oscillator.

2.2 The output on each range should be at least 6 volts when measured across the output terminals with a vacuum-tube voltmeter similar to the General Radio Type 1800-A.

2.3 Readjust C-3 slightly for maximum output with the switch set to the 1 Mc position.

3.0 REPLACEMENT TUBES

3.1 To eliminate instability when V-2 and/or V-3 are replaced, it is advisable to operate them in the instrument for at least 8 hours before any adjustments are made. New tubes may cause the 100-kc multivibrators to drop out of control until they have reached stability. If this procedure is followed the nuisance of continual readjustment will be eliminated. Common practice suggests the aging

continual readjustment will be eliminated. Common practice suggests the aging of tubes for 48 hours under operating conditions.

4.0 INABILITY TO MAINTAIN CONTROL OF THE MULTIVIBRATORS ON 100 KC AND 10 KC:

4.1 Power supply voltage must be 300-350 volts d.c. and 6.0 to 6.6 volts a.c when connected to the oscillator.

4.2 New tubes that have not been aged may cause difficulty in keeping the multivibrators locked in frequency. See Section 3.1.

4.3 Instrument should be operated at normal room temperatures. High ambient temperatures may cause the multivibrators to go out of control.

4.4 When the instrument is first turned on it should be allowed to operate for 5-10 minutes before using. This allows the voltages and temperature to reach a stable condition so that the multivibrators will remain in control. When the instrument has been idle for a long period of time, this warm-up time should be increased.

5.0 FREQUENCY ON 1-MC SETTING IS BEYOND THE RANGE OF C-11.

5.1 Be sure that the frequency being used as a standard for adjusting the crystal frequency is accurate.

5.2 If C-11 is at maximum capacitance from previous adjustments and cannot be increased further, a small mica capacitor of 20-30 $\mu\mu$f may be connected across it so that C-11 will be centered at a frequency of 1 Mc. This condition may indicate that crystal is subject to continual drift and should be replaced.

5.3 When C-11 is at minimum capacitance from previous adjustments and can not be reduced further at a frequency of 1 Mc, crystal Q-1 must be replaced.

6.0 TUBE VOLTAGES

6.1 Conditions of measurement:

Switch set to 10 kc.

Use a 20,000-ohms-per-volt d-c meter connected between the tube socket terminal and the chassis (ground) except where designated "ac". Use a 1,000-ohms per volt meter for a-c measurements.

Do not use a tube socket adaptor. Make measurements directly at the tube socket terminal.

The following values were obtained using the Type 1203-A Unit Power Supply having 338 volts d-c and 6.4 volts a-c when connected to the oscillator. Variations corresponding to other power supply voltages must be taken into account.

Readings are subject to 10% variation, except the grid voltages at terminals 2 and 7 of each tube, which may vary up to 20% depending upon the condition of the tube and the signal r-f voltage.

Values in parentheses are r-f signal voltages measured with a vacuum-tube voltmeter with a 10-megohm input similar to the General Radio Type 1800-A.

		TUBE SOCKET TERMINAL NUMBER								
TUBE	TYPE	1	2	3	4	5	6	7	8	9
V-1	12AT7	260	0	8.5 (11.3)	6.4 a.c.	6.4 a.c.	278	0	4.3 (1.9)	0
V-2	12AT7	190	-5.9 (27)	10.2	6.4 a.c	6.4 a.c	190	-8.9 (24)	10	0
V-3	12AT7	102	-8.9 (20)	5.9	6.4 a.c.	6.4 a.c.	107	-8.9 (20)	5.9	0

7.0 TUBE SOCKET RESISTANCE MEASUREMENTS

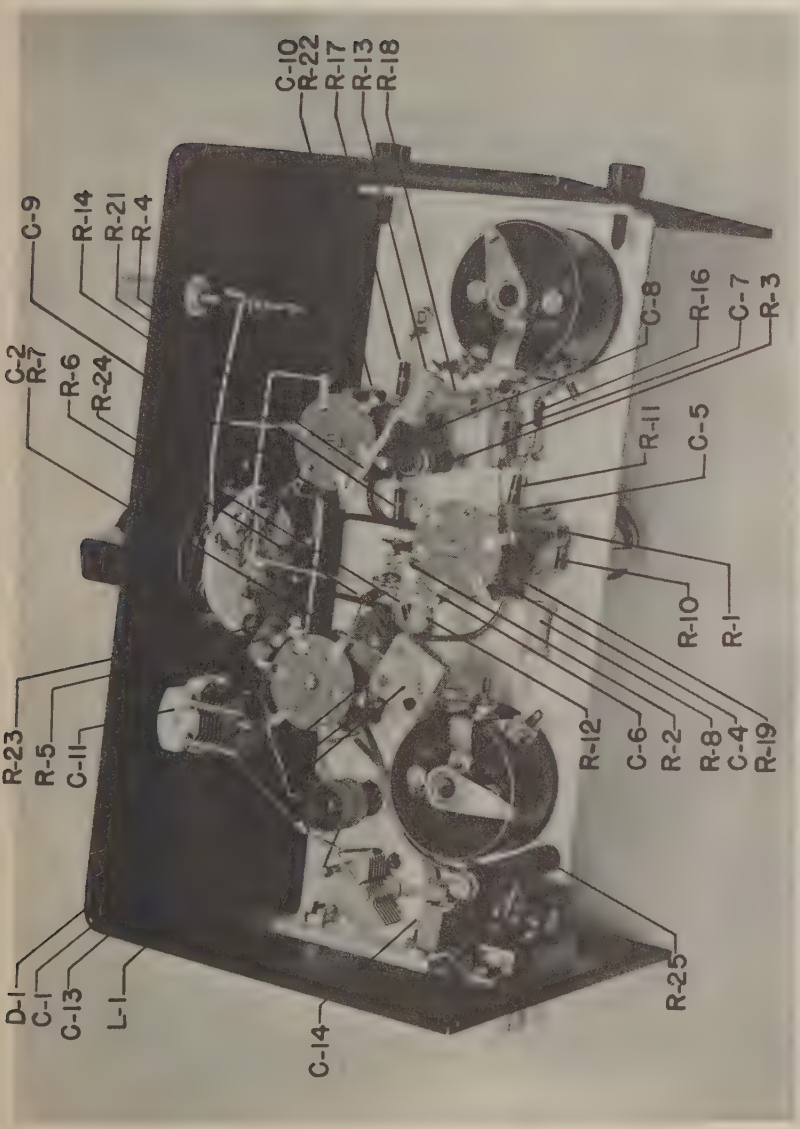
7.1 Conditions of Measurement:
Power supply disconnected.
Switch set to 10 kc.
Terminal No. 15 of PL-1 connected to chassis to ground the B voltage supply.

Values are in ohms, k = kilohms, and subject to 10% variation.
Measurements made with an ohmmeter connected between each tube socket terminal and the chassis (ground).

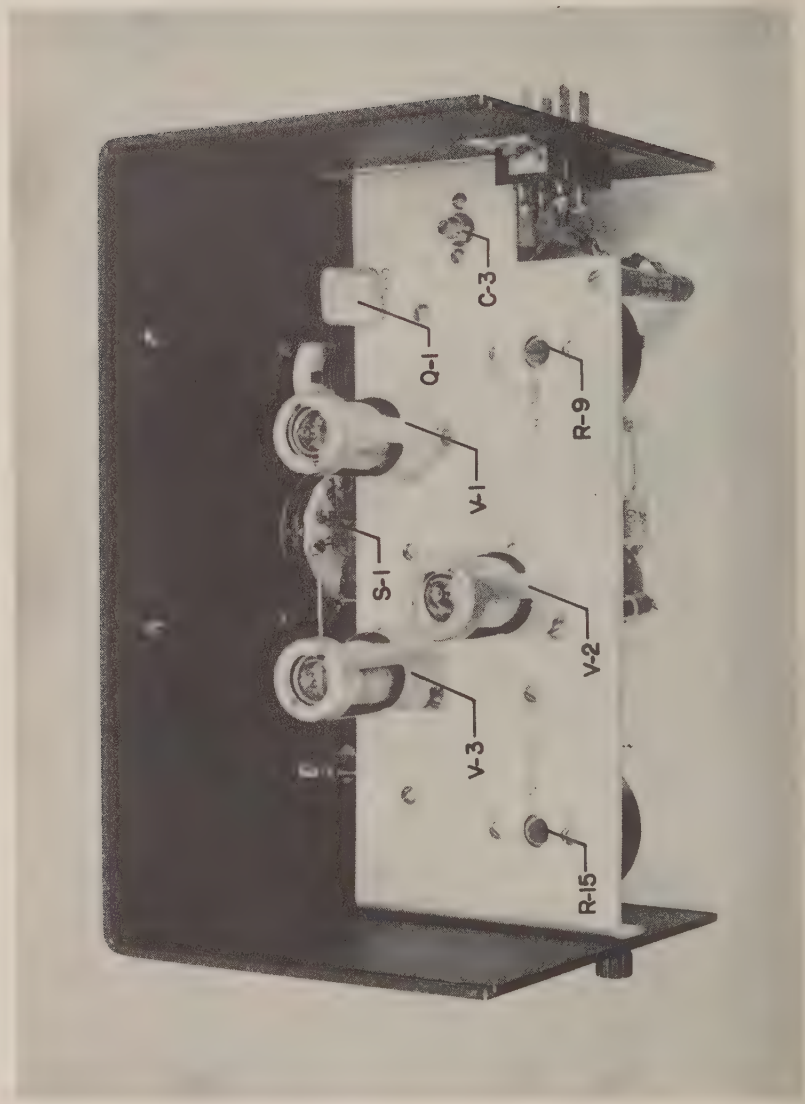
		TUBE SOCKET TERMINAL NUMBER								
TUBE	TYPE	1	2	3	4	5	6	7	8	9
V-1	12AT7	* 4.5 k	100 k	1 k	0.9	0.9	4 k	0	1 k	0
V-2	12AT7	11 k	6.7 k 11.7 k	1 k	0.9	0.9	11 k	9 k	1 k	0
V-3	12AT7	40 k	6.5 k 11.5 k	1 k	0.9	0.9	40 k	9 k	1 k	0

* Subject to 25% variation depending on diode, D-1. Reverse ohmmeter reads 350 k.

Resistance of L-1 18 ohms.



Interior View of Type 1213-A Unit Crystal Oscillator



Interior View of Type 1213-A Unit Crystal Oscillator

TYPE 1213-A UNIT CRYSTAL OSCILLATOR

PARTS LIST

RESISTORS

R-1	= 10	k Ohms	± 5%		REC-41BF
R-2	= 10	k Ohms	± 5%		REC-41BF
R-3	= 39	k Ohms	± 5%		REC-41BF
R-4	= 39	k Ohms	± 5%		REC-41BF
R-5	= 0.1	Megohm	± 5%		REC-20BF
R-6	= 1	k Ohm	± 5%		REC-20BF
R-7	= 1	k Ohm	± 5%		REC-20BF
R-8	= 5.5	k Ohms	± 1%	CCCo	X-1/2
R-9	= 5	k Ohms	± 5%		301-465
R-10	= 1	k Ohm	± 5%		REC-20BF
R-11	= 1	k Ohm	± 5%		REC-20BF
R-12	= 7.9	k Ohms	± 1%	CCCo	X-1/2
R-13	= 5.5	k Ohms	± 1%	CCCo	X-1/2
R-14	= 1	k Ohm	± 5%		REC-20BF
R-15	= 5	k Ohms	± 5%		301-465
R-16	= 1	k Ohm	± 5%		REC-20BF
R-17	= 1	k Ohm	± 5%		REC-20BF
R-18	= 7.9	k Ohms	± 1%	CCCo	X-1/2
R-19	= 200	Ohms	± 5%		REC-20BF
R-20	= 200	Ohms	± 5%		REC-20BF
R-21	= 51	Ohms	± 5%		REC-20BF
R-22	= 51	Ohms	± 5%		REC-20BF
R-23	= 3	k Ohms	± 5%		REC-41BF
R-24	= 1	k Ohms	± 5%		REC-20BF
R-25	= 1	k Ohm	± 5%		REPO-1078

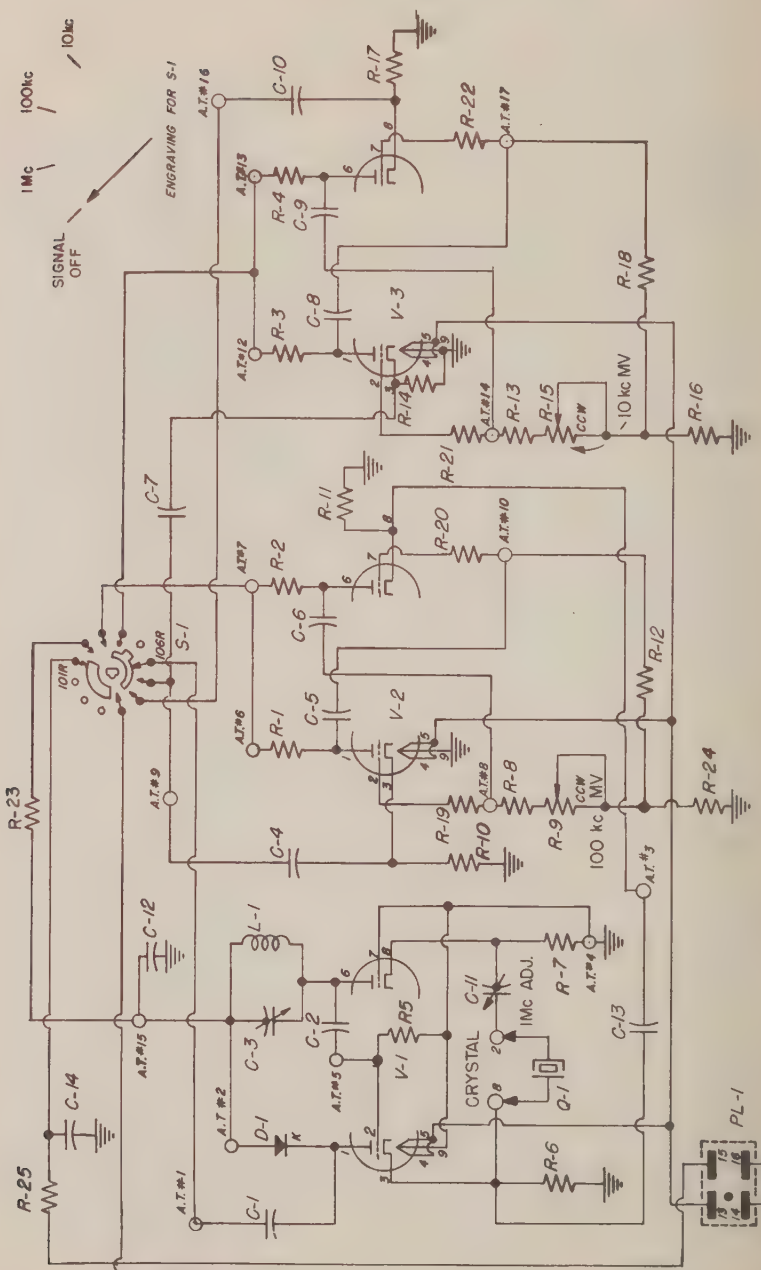
CONDENSERS

C-1	= .000015	μf	± 10%	COM-20B
C-2	= .0005	μf	± 1 %	COM-20E
C-3	= 4 - 50	μμf		COA-2
C-4	= .0001	μf	± 10%	COM-20B
C-5	= .00028	μf	± 1%	COM-20E
C-6	= .00028	μf	± 1%	COM-20E
C-7	= 30	μμf	± 10%	COM-20B
C-8	= .0015	μf	± 1%	COM-30E
C-9	= .0015	μf	± 1%	COM-30E
C-10	= .001	μf	± 10%	COM-20B
C-11	= 4 - 50	μμf		COA-2
C-12	= .0025	μf	± 10%	COM-30B
C-13	= 20	μμf	± 10%	COM-20B
C-14	= .01	μf	± 10%	COM-35B

L-1	= Choke	ZCHA-28
D-1	= Crystal	IN34-A
PL-1	= Plug	CDMP-476-4
J-1	= Binding Post	BP-5
J-2	= Binding Post	BP-10
S-1	= Switch	SWRW-62
Q-1	= Crystal 1 Mc	CRP-3

TUBES

V-1	RCA	12AT7
V-2	RCA	12AT7
V-3	RCA	12AT7



Wiring Diagram for Type 1213-A Unit Crystal Oscillator

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